4th Semester	REC4G003	Brain Control Interface	L-T-P 3-0-0	3 CREDITS

Module - I   (10 Hrs.)

Introduction to Brain Control Interface
Fundamentals of BCI – Structure of BCI system – Classification of BCI: Invasive, Non-invasive and Partially invasive BCI-Brain signal acquisition, Signal Preprocessing, Artifacts removal.

Module – II   (10 Hrs.)

Electrophysiological Sources
Sensorimotor activity –Neuronal activity in motor cortex and related areas- Electric and magnetic fields produced by the brain- signals reflecting brain metabolic activity- Mu rhythm, Movement Related Potentials – Slow Cortical Potentials - P300 Event related potential - Visual Evoked Potential - Activity of
Neural Cells - Multiple Neuromechanisms

Module - III   (10 Hrs.)

Feature Extraction Methods
Time/Space Methods – Fourier Transform, Wavelets, AR, MA, ARMA models, Bandpass filtering, Template matching, Kalman filter, PCA, Laplacian filter – Linear and Non-Linear Features.

Module - IV   (07 Hrs.)

Feature Translation Methods
Linear Discriminant Analysis –Nearest neighbours, Support Vector Machines - Regression – Learning Vector Quantization – Gaussian Mixture Modeling – Hidden Markov Modeling – Neural Networks.

Module - V   (08 Hrs.)

Applications of BCI
Study of BCI Competition III – Dataset I, II, III, IV and V, Functional restoration using Neuroprosthesis - Functional Electrical Stimulation, Visual Feedback and control - External device controllers, Case study: Brain actuated control of mobile Robot. Ethical issues in BCI research

Books:

Reference Books:

- Jonathan Wolpaw,Elizabeth Winter Wolpaw,'Brain Computer Interfaces: Principles and practice", Edition 1, Oxford University Press, USA, January 2012
- Special Issue on Brain Control Interfaces, IEEE Transactions on Neural Systems and Rehabilitation Engineering, Vol 14, June 2006.
- R. Spehlmann, "EEG Primer", Elsevier Biomedical Press, 1981.
- Bernhard Graimann, Brendan Allison, Gert Pfurtscheller, "Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction", Springer, 2010

- Ali Bashashati, Mehrdad Fatourechi, Rabab K Ward, Gary E Birch," A survey of signal Processing algorithms in brain–computer interfaces based on electrical brain signals" JOURNAL OF NEURAL ENGINEERING, VOL.4, 2007, PP.32-57
- Arnon Kohen, "Biomedical Signal Processing", Vol I and II, CRC Press Inc, Boca Rato, Florida.
- Bishop C.M., "Neural networks for Pattern Recognition", Oxford, Clarendon Press, 1995.
- Andrew Webb, "Statistical Pattern Recognition", Wiley International, Second Edition, 2002.
- Torsten Felzer, "On the possibility of Developing a Brain Computer Interface", Technical Report, Technical University of Darmstadt, Germany,2001.
- Wolpaw J.R, N.Birbaumer et al, "Brain control interface for Communication and control", Clinical Neurophysiology, 113, 2002.
- Jose del R.Millan et al, "Non-invasive brain actuated control of a mobile robot by human
- EEG", IEEE Transactions on biomedical Engineering, Vol 51, No.6, 2004 June.
- S.Coyle, T.Ward et al, "On the suitability of near infra red systems for next generation Brain Computer interfaces", Physiological Measurement, 25, 2004.
- Carlo Tomasi, "Estimating Gaussian Mixture Densities with EM – A Tutorial", Duke University, 2000.
- R.Dugad, U.B Desai, "A Tutorial on Hidden Markov Modeling", Signal Processing and Artificial Neural Networks Laboratory, IIT Bombay, 1996.
- http://ida.first.fhg.de/projects/bci/competition_iii

Course Outcomes:
Capable of acquiring the brain signal in the format required for the specific application
1. Well prepared for preprocessing the signal for signal enhancement
2. Ability to extract the dominant and required features and classify the signal for applications